From: MORASH, MELANIE
Sent: Friday, January 31, 2020 4:08 PM
To: Cashwell, James M CERG
Cc: DiLorenzo, James; Brandon, William; CEsakkiperumal; Andy Davis; Bowen, Libby T; Kerry R Tull; Peter H. Thompson; jbrunelle@nobis-group.com; jlambert@nobis-group.com; Walter, Nelson; Steve Humphrey; Kelly, Christopher; Jennings, Lynne; Ng, ManChak; Pechulis, Kevin; White, Sarah; Carroll, Courtney; garry waldeck; Janet Waldron
Subject: Olin Chemical Superfund Site - Wilmington, MA - EPA Comments - Data Gaps Work Plan - Phase I
Attachments: 1-31-20_EPA Tech Memo_Review of Olin Data Gaps Work Plan.pdf; 8-22-19 Nobis Tech Memo_ 2019 Data Gaps Work Plan Review.pdf; Comment Memo Figures.pdf

Good afternoon, James,

Thank you for submitting the Data Gaps Work Plan, prepared by Geomega on behalf of Olin, and dated August 2, 2019 (Work Plan). The Work Plan presents a phased approach for data collection activities to close remaining data gaps at the Olin Chemical Superfund Site (Site).

EPA greatly appreciates Olin's efforts to reach technical consensus on key issues and acknowledges the significant work that has gone into producing a work plan product that reflects the evolving consensus. In general, the Work Plan captures the outcome of numerous technical discussions between the EPA and Olin teams.

EPA is generally in agreement with the phased, iterative approach as outlined in the Work Plan, specifically, that the general plan for subsequent efforts (Phase II, Phase III, etc.) will be based on an evaluation of the results of the Phase I activities. Note that EPA may determine that additional investigations that have not been anticipated in the Work Plan will be needed. For example, it may be necessary to drill into bedrock beneath the Plant B area, which is not currently included in the Phase I scope. Drilling into shallow bedrock and perhaps deeper bedrock may increase in importance depending on the results of the current phase of work.

EPA reserves the right to suggest additional and/or alternate sampling/survey locations based on a full review of surface geophysics, borings, and other data as it becomes available. Additionally, well replacement activities should be included in Phase II work for wells or sampling ports that have been compromised.

Finally, it must be acknowledged that the scale of the Main Street dense aqueous-phase liquid (DAPL) pool area is much larger than the Containment Area and Jewel Drive DAPL pool areas. The proposed seismic surveys will therefore result in a coarser "grid" and hence a lower level of resolution than that which will be obtained for the Containment Area and Jewel Drive areas. While it may be necessary to collect additional seismic data at a tighter line spacing in selected areas of the Main Street DAPL pool area as a follow-up, decisions in this regard can be deferred until the currently proposed data is collected, evaluated, and transmitted to EPA for discussion.

This e-mail specifically responds to the Phase I activities proposed in the Work Plan. These activities include the following: seismic reflection surveys to address bedrock surface data gaps; aerial electromagnetic (AEM) surveys in the Maple Meadow Brook (MMB) area to further characterize bedrock topography and groundwater; direct push soil and groundwater sampling in the northern portion of the Olin property and off-property groundwater areas to the north to address the extent and distribution of n-nitrosodimethylamine (NDMA) impacts; synoptic groundwater level collection; replacement of damaged well GW-26; and installation and monitoring of surface water gauges.

Two technical memos and a set of figures (dated December 17, 2019) are attached to this e-mail – one prepared by EPA's hydrogeologists, Bill Brandon and Christopher Kelly, dated January 31, 2020, and the other by EPA's technical support contractor, Nobis, dated August 22, 2019 (together, Comment Memos). EPA appreciates Olin's consideration of the Comment Memos, which need to be considered further before EPA can approve the initiation of the geophysical

surveys. However, EPA will make every effort to expedite the review and approval of the Phase I Work Plan activities, once these additional comments have been reviewed and incorporated into the proposal.

In general, the majority of the geophysical alignments proposed for the Containment Area are acceptable. However, the Comment Memos (and accompanying figure) suggest a few modifications, in order to maximize overlap with existing boreholes. These adjustments to the alignments will serve to improve and constrain the seismic data as well as to validate previous estimations of bedrock from other methods, such as bedrock "refusal," or other estimations from drilling. Significant discrepancies, if any, will thus be highlighted.

In addition to the proposed modifications, several new seismic lines are proposed to increase resolution in key areas of the Site and to create a more regular grid spacing, which will contribute to a better result by increasing resolution and decreasing bias.

In particular, EPA believes that additional work, beyond that currently proposed in the Work Plan, is needed for the area north of the Olin property (GW-413 area). Specifically, EPA's emerging Conceptual Site Model (CSM) for the Site groundwater contaminant plume suggests that *steeply dipping fractures* are important and should be investigated as potential pathways in the bedrock, in addition to the *shallowly-dipping sheeting fractures* discussed in the Work Plan. EPA remains concerned that the NNW-striking plume shape, which also corresponds to the general direction of the groundwater head gradient, is influenced by NW-striking fractures that cross-cut the regional NE-SW fabric.

The current proposal in the Work Plan is weak in that it allows for very few locations for seismic data or follow-up confirmatory borings to interrogate the region where the *plume core* is likely to be based on Olin's CSM. It is therefore imperative that the Work Plan be augmented to allow for validation and delineation of the plume within and beyond the known limits of the current configuration.

While accepting elements of the Work Plan, EPA has added several seismic reflection lines and additional GeoProbe locations. The additional seismic lines are intended to resolve the position and shape of the top of bedrock and related features; the additional GeoProbe locations are needed to resolve groundwater concentration gradients in the high-concentration core areas as well as confirming the shape of the top of bedrock surface in the general plume region.

Regarding the final selections for additional deep monitoring, multi-port extraction wells and control points in the Containment Area, the EPA and Olin teams have come to the consensus that these will be deferred until the seismic data can be collected and integrated with the 2019 Containment Area drilling data. At that time, the teams will work together once the AEM and supplementary data are in hand, to determine the locations and depths for the next phase of borings and well installations.

Please provide a response-to-comment letter for the Comment Memos and a revised Work Plan, as appropriate, for EPA's review and approval, within 45 days of your receipt of this e-mail.

Regards,

Melanie Morash

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From: Steven Humphrey <shumphrey@geomega.com>
Sent: Friday, August 2, 2019 5:47 PM
To: Jennings, Lynne <Jennings.Lynne@epa.gov>; MORASH, MELANIE <morash.melanie@epa.gov>; garry waldeck <Garry.Waldeck@state.ma.us>
Cc: DiLorenzo, James <dilorenzo.jim@epa.gov>; Brandon, William <Brandon.Bill@epa.gov>; James M CERG Cashwell <JMCashwell@olin.com>; CEsakkiperumal <CEsakkiperumal@olin.com>; Andy Davis <andy@geomega.com>; Libby T Bowen <libby.bowen@woodplc.com>; Kerry R Tull <kerry.tull@woodplc.com>; Peter H. Thompson <peter.thompson@woodplc.com>; jbrunelle@nobis-group.com; jlambert@nobis-group.com
Subject: Data Gaps Work Plan

Greetings Lynne and team,

On behalf of Olin, please use the link to our ftp site to download the files for the Data Gaps Work Plan: combined text/tables/figures/appendices (Data Gaps Work Plan 8-2-2019.pdf), word and excel files for the text and tables are also included.Please do not hesitate to contact me with questions.

http://ftp.geomega.com/
username: olin
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Regards,

Steven L. Humphrey PG
Hydrogeologist/Groundwater Modeler

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MEMORANDUM

To: Melanie Morash; RPM, OSRR, US EPA Region 1

From: W. Brandon, Technical Support Hydrogeologist, OSRR, US EPA Region 1

C. Kelly, Technical Support Hydrogeologist, OSRR, US EPA Region 1

cc: EPA site Team (LAJ/JD/KP/MN/CK), Nobis (JL/JB)

Date: January 31, 2020

Subject: Conditional Approval of Surface Geophysical Data Collection portion of Data Gaps Work Plan

Introduction:

Olin has created a work plan to address a variety of significant data gaps at the site. The most recent version of that document, entitled, *Data Gaps Work Plan*, dated August 2, 2019, was prepared by Geomega, Inc., and transmitted to EPA in a letter to Lynne Jennings (EPA) from James Cashwell (Olin) on August 2, 2019. The content of the work plan has been discussed in meetings and teleconferences over recent weeks. Based on recently completed drilling within the Containment Area (CA), the complexity of the top-of-bedrock (TOR) surface has been highlighted. In this regard, expediting *seismic reflection* efforts and other *surface geophysical surveys* designed to more accurately resolve the shape of the TOR surface has become a critical project objective. The following comments are therefore focused to the surface geophysical surveys and related elements of the *Data Gaps Work Plan*. EPA will provide further comment on other aspects of the *Data Gaps Work Plan,* if appropriate, under separate cover.

General Comments:

1. The August 2, 2019 version of the Data Gaps Work Plan does a good job in capturing the technical discussions between Olin, EPA, and other members of the greater site team up to that time. EPA greatly appreciates Olin's efforts to reach technical consensus on key issues, and to produce work plans that reflect evolving consensus. In this respect, most of the surface geophysical work outlined in the *Data Gaps Work Plan* is acceptable as described therein. There are, however, a few issues which are highlighted in the comments below which should be considered further before the surface geophysical surveys are initiated.
2. EPA's subcontractor, Nobis, Inc., prepared a review of the Comprehensive Data Gaps Work Plan, dated August 22, 2019. EPA endorses these comments and recommendations, particularly as they relate to the surface geophysical surveys. In a few instances, however, EPA has augmented or modified some of these comments below. As noted above, EPA's review focusses on the surface geophysical surveys and related tasks. We will provide further comments on other aspects of the Data Gaps workplan under separate cover.
3. The Data Gaps Workplan is structured to allow work to proceed in phases. Data collected in initial phases will be evaluated and will affect subsequent phases, as is appropriate. In this

respect, while some general approximations can be made at this time regarding such matters as the number and location of extraction wells to be installed in various areas of the site, locations and depths for permanent monitoring wells, multi-port monitoring points, etc., recent experiences in the Containment Area have underscored EPA's previously expressed concerns regarding the complexity of the TOR surface. In this respect, it will be necessary to complete surface geophysical surveys and related work (soil borings, direct-push borings, etc.), and to integrate this information to further resolve the TOR surface before locations and numbers of wells and borings targeted to deep regions of the TOR surface can be finalized. In this respect, EPA's recommendations, below, should be considered as preliminary, and we will reserve the right to suggest additional and/or alternate locations based on full review of surface geophysics, borings, and other data as it becomes available.

4. Drilling Methodology: Recent drilling in the Containment Area using the '*mini-sonic*' method indicates that additional discussions are needed prior to installation of bedrock wells and/or borings which target the TOR surface and deeper intervals within the bedrock. A revised drilling approach may be necessary given the difficulties associated with recovering representative samples from the upper fractured and/or weathered intervals of the bedrock. It may be worth considering use of multiple methods in a deliberate sequence to maximize information quality. Whatever method(s) are selected, it is essential to maximize collection of representative samples of geologic materials from the bedrock/overburden interface. If this interface is transitional/gradual in nature, ideally a relatively intact continuous core of the till, boulders, and weathered/fractured rock materials will be recovered to support an accurate characterization of the overburden-bedrock transition zone, and the uppermost bedrock intervals which may contain significant sub-horizontal sheeting fractures or other important features. A drilling method which maximizes characterization and resolution in this interval is needed. While caution is also needed to minimize drag-down of contaminants from higher levels, efforts should be made to collect key data within the overburden/bedrock transition zone and upper portions of the bedrock before these intervals are cased off. One example of a possible alternative approach is as follows:

    a. Penetrate overburden using Rotosonic methods; to the extent possible, obtain continuous and undisturbed core of penetrated material to enable accurate identification, thickness determination, and logging of key physical characteristics of all geologic units penetrated.
    b. Install temporary or permanent casing at first indication of TOR surface identified by Rotosonic
    c. Penetrate uppermost 20-30 feet of material beneath casing using conventional or modified triple-tube diamond rock coring methods in conjunction with spun or driven casing, etc. Alternatively, a modified roto-sonic method could be considered to specifically address the overburden-bedrock transition zone. A goal would be to produce a relatively *undisturbed* and *continuous* core of till, boulders and weathered/fractured rock through this complex transitional interval, into (relatively) unweathered and unfractured "*intact*" bedrock
    d. Set permanent casing in 20-30 feet into *intact* bedrock and drill deeper intervals using air-rotary methods; perform downhole borehole logging with full suite of tools.
    e. This information should be compiled and integrated to produce high quality boring logs including enabling accurate identification, thickness determination, and logging of key physical characteristics of all geologic units penetrated, including unconsolidated deposits, consolidated bedrock, and the transition zone from overburden to bedrock,

e.g., overburden materials, till, weathered and/or highly fractured bedrock, lightly fractured "intact" bedrock.

f. This information will inform selection of key intervals for completion as permanent monitoring points. The completed borehole may be used for monitoring key zones in the mid- to deeper-level bedrock. Separate borings may be advanced adjacent to the bedrock location to allow for co-located monitoring intervals in overburden, till, upper bedrock and at material interfaces (e.g. BR/Overburden contact) as dictated by the data.

EPA is open to a range of approaches, but reliance on a single drilling method may not be appropriate given the variability of geologic materials and range of data needs. Additional discussions are needed in order to reach a technical consensus for the best drilling approach(es), in consideration of *all* the data objectives. Drilling in DAPL source zone may require additional specialized casing/approaches. Further discussions are needed.

5. <u>*Definitions for Key zones at Overburden-Bedrock Transition zone*</u>: The site team needs to come to a technical consensus for characteristics of the principal material types to be encountered within the key transition zone from unconsolidated overburden deposits to consolidated bedrock. Transitional units include the following (top-down order):

- Unconsolidated glacially deposited units, e.g., outwash sands and gravel.
- Weakly consolidated till, e.g., ablation till
- Dense consolidated till, e.g. lodgment till
- Boulders within glacial deposits or near till/bedrock contact
- Highly weathered and/or fractured bedrock
- Moderately weathered and/or fractured bedrock
- Competent bedrock, e.g., relatively unfractured and unweathered

Previous experience at the site has shown that contacts between these material types may be distinct or transitional and may vary laterally. Moreover, depending on drilling method used, poor sample recovery may obfuscate the nature of the materials present. In this respect, consensus is needed for the working definition of these units for this project. EPA suggests that Wood and Geomega consult with geotechnical engineering experts in their firms to construct working definitions. For example, "competent" bedrock may be defined in terms of the commonly employed rock quality designation (RQD) factor. Once consensus for material definitions and characteristics is reached, it will be necessary to develop a site team consensus for drilling approach with can discriminate between the various material types. Please see general comment 4, above.

6. <u>*Validation, Calibration, and Resolution of Surface Geophysical Methods*</u>; For all the surface geophysical methods to be employed, standard operating procedures (SOPs) should be provided. The SOPs should detail the calibration procedures to be employed, including the recommended time intervals for recalibration. In addition to internal instrument calibration, methods for calibrating geophysical *system responses* to known hard data points such as bedrock surface elevations determined from borings should be discussed. For example, vertical seismic profiles should be conducted in areas of known stratigraphy. As noted in comments below, EPA has modified many of the proposed geophysical alignments slightly to incorporate additional hard data points for direct comparison/calibration. Validation efforts, such as those

discussed in Nobis' comments dated August 22, 2019, including comparison of individual method results to other geophysical methods and hard data points should also be discussed. Lastly, lateral and vertical resolution expected from each method, as deployed for this project should be quantified and tabulated to the extent possible, including the accuracy and precision of the data. After data is collected and analyzed, a final assessment of data accuracy and precision should be included in the reports.

7. *Containment Area Seismic Alignments*: The majority of the geophysical alignments proposed for the Containment area are generally acceptable. However, a closer examination with the recent drilling experience in the CA during November 2019, suggest a few minor modifications should at least be considered, as summarized in the following table and associated figure. EPA is proposing several slight adjustments to the alignments in order to maximize overlap with existing boreholes. This will serve to improve and constrain the seismic data as well as to validate previous estimations of bedrock from other methods such as bedrock "refusal" or other estimations from drilling. Significant discrepancies, if any, will thus be highlighted. In addition to the proposed modification, several new lines are proposed to increase resolution in key areas of the site and to normalize line spacing to create a more regular grid spacing which will contribute to a better result by increasing resolution and decreasing bias.

Geophysical Survey Line	Status	Comment
1	Modify	Rotate slightly *counterclockwise* to intersect OC-BB-1-2018, GW-CA2, GW-24 (see figure)
2	Modify	Rotate slightly *clockwise* to intersect GW-408S/D, (see figure)
3	Modify	Center on MP-1 and rotate slightly *clockwise* to intersect GW-38D
4	Modify	Center on OC-BB-2-2018 and rotate slightly *clockwise* as shown on attached figure to maximize control point intersections
5	Concur	
6	Concur	
7	Concur	
8	Modify	Extend 200 feet to southeast to intersect control point shown on attached figure
9	Concur	
10	New	New line to increase/normalize resolution in northwest quadrant of CA; line extends from railroad track on SW end to GW-24, to GW-22D, to GW-34SR, and approximately 50 feet further to the northeast on the same alignment
11	New	New line to increase/normalize resolution in CA, particularly in northeast quadrant where recent drilling detected anomalous deep areas on TOR surface ; line extends from south ditch on SW end to GW-202BRS/D, to PZ-24, through control points near GW-6S/D shown on attached figure and approximately 50 feet further to the northeast on the same alignment

12	New	New line to increase/normalize NW-SE resolution in northwest quadrant of CA; alignment connects OC-BB-1-2018 with GW-412 to the SE, extending approximately 100 feet southeast of the slurry wall and ~ 100 feet northwest of OC-BB-1-2018 on the same NW-SE alignment, intersecting the unlabeled control points shown on the attached figure.
13	New	New line to address critical region in southwest corner of slurry wall; alignment connects GW-408D with GW-202BRS/D to the SE, extending approximately 100 feet southeast of the slurry wall and ~ 50 feet northwest of GW-408D on the same NW-SE alignment
14	New	New Line to assess conditions at critical western margin of CA to better constrain possible geologic controls and connections with Jewel Drive DAPL pool. Alignment begins near the weir structure and South Ditch and extends (from S to N) through GW-38D, GW-408D, GW-37D, GW-CA1 and beyond to the northeast as shown on the attached figure

As discussed in recent communications, it will be advisable to defer final selections for additional deep monitoring, multi-port, extraction wells and control points at the CA until the seismic data can be collected and integrated with recently collected drilling data to determine consensus locations and depths for the next phase of borings and well installations.

8. *Jewell Drive Area Seismic Alignments*: The Jewell Drive area remains a difficult challenge. Meeting the technical objective of installing MP wells and extraction wells in the deepest part of the "basin" is hampered by the position of the building directly on top of the interpreted depression on the TOR surface. In this respect, in addition to the seismic lines discussed below, low-frequency GPR is recommended in the small areas where MP's and/or confirmation borings are called for in the current plan. This is designed to increase resolution in these key areas. Depending on the results of this work, if the TOR surface is more complex than previously thought, or if locating key wells in deep pockets on the TOR surface proves difficult, it may be advisable to consider extraordinary steps such as performing geophysical surveys within the building footprint. While such a proposition is fraught with technical difficulties and logistical pitfalls, it may be the only way to determine where the deep targets are located within that region. Specialized deployments such as Single-Station Passive Seismic (SSPS) using passive micro-seismometers (deployed in multiple locations) may have utility if this becomes necessary.

   The following table contains minor adjustments and other recommendations for the proposed seismic alignments at the Jewell Drive area.

Geophysical Survey Line	**Status**	**Comment**
1	Extend	Extend ~ 50 feet to south along proposed alignment
2	Modify	Rotate slightly counterclockwise as shown on attached figure and extend in SSE direction to south of drainage ditch
3	Modify	Move line slightly to east as shown on attached figure to intersect control points

4	Extend	Extend 40+ feet to east and 80+ feet west along proposed alignment
5	Concur	
6	Extend	Extend ~ 60+ feet to SE along proposed alignment to south of drainage ditch
7	New	New line oriented SW from proposed MP location through current extraction area (EW-1, ML-1)
8 GPR	New	Proposed low frequency GPR survey grid within 50X100 area in location proposed for MP well (see Figure)
9 GPR	New	Proposed low frequency GPR survey grid within 250X100 ft area where numerous confirmatory borings are planned

9. *Jewell Street DAPL Area, proposed extraction well locations*; EPA tentatively has selected the eight locations shown on the attached figure as favorable locations for TOR confirmation and/or DAPL extraction in view of the current CSM. Naturally, this is subject to revision based on new information, access or other logistical factors, etc. Nevertheless, effective remediation will require directly accessing the DAPL, and this may ultimately require alternative approaches and/or inconvenient solutions. EPA is committed to working with Olin to reach consensus on the most practicable approach to this challenging problem.
10. *Main Street DAPL Pool Area Seismic Alignments*:
    The following table contains limited suggestions for modifications or additions to proposed seismic reflection survey alignments in the Main Street DAPL pool area. It must be acknowledged that the scale of MSDP area is much larger than the CA and Jewel drive areas previously discussed. The proposed seismic surveys will therefore result in a coarser "grid" and hence a lower level of resolution than that which will be obtained for the CA and Jewel drive areas. It may be necessary to collect additional seismic data at a tighter line spacing in selected areas of the MSDP area as a follow-up. We propose deferring decisions in this regard until the currently proposed data is collected, evaluated, and transmitted for discussion.

Geophysical Survey Line	**Status**	**Comment**
1	Concur/Extend	Consider extending ~ 300 ft to SW to intersect control point and to evaluate potential continuity of NE-SW oriented bedrock low across Main Street
2	Modify	Rotate slightly to NW to maximize intersection with control points; Eliminate "dog-leg" portion of the line to the SE and extend northern segment of revised alignment southward to southern end of MSDP area
3	Concur/Extend	Consider extending ~ 100 feet to SE to intersect control point
4	Concur	
5	Concur	
6	Concur	
7	Concur	
8	Concur	
9	Concur/Extend	Extend ~ 200 ft to NE to intersect control point and better define northern edge of smaller depression

10	Concur/Extend	Extend ~ 100+ ft to NW to intersect line 16 and possible NE-SW striking feature near the projected intersection with line 16
11	Concur	
12	Concur/Extend	Extend ~ 300 ft to east to intersect control points and line 17; provide additional data in vicinity of former Stamina pumping well
13	Concur	
14	Concur/Extend	Extend 100-200 ft to SE to interrogate subsurface beneath small wetland feature
15	Replace	Eliminate proposed alignment and replace with new alignment shown on figure to intersect control points and line 18; provide additional data in vicinity of former Stamina pumping well
16	Concur	
17	Concur	
18	Concur	
19	Concur	
20	Concur	
21	Concur	

11. *Main Street DAPL Pool Area, proposed confirmatory borings/extraction well locations*; EPA tentatively has selected the 17 locations shown on the attached figure as tentative locations for TOR confirmation and/or DAPL extraction in view of the current CSM. The number and locations for proposed extraction wells, multi-port monitoring wells, and conventional monitoring wells in key hydrostratigraphic zones will be revisited and revised as necessary based on the new information to be collected.
12. *Maple Meadow Brook (MMB) Area;* EPA believes that it is premature to determine the number of locations and depths for which proposed extraction wells, multi-port monitoring wells, and conventional monitoring wells in key hydrostratigraphic zones will be needed in the large MMB area. We will revisit this issue once AEM and supplementary data are in hand and available for review.
13. *North of Olin (GW-413) area*; EPA believes that additional discussion is needed relative to the CSM for the North of Olin (GW-413) area. While not well articulated in the August 2, 2019 Work Plan, several facts about the situation here are worth mentioning here in relation to the CSM, and how that CSM informs the work plan. As shown on Figure 7 of the work plan, the NDMA plume core (indicated at greater than 1100 ng/l) is indicated as a thin zone on the order or 100-150 feet thick laterally centered on GW-413. The plume shape shown on Figure 7 has a longitudinal axis oriented in the NNW direction. Since GW-413 is a bedrock well with a limited open interval from 37-61.5 ft btoc, the extent of the plume in upper portion of the bedrock is a clear investigation target. However, the proposed GeoProbe work will not address this objective directly, as the bedrock will not be penetrated by these explorations. Regarding bedrock, while nothing is mentioned regarding the predominantly moderately- to steeply-dipping, NE-SW striking fractures intersected by GW-413, the work plan states that, "USEPA has suggested the potential for "*shallowly-dipping sheeting fractures*", to serve as a potential transport mechanism through the bedrock from contaminated areas to the south. In this regard, it must be stated, that while EPA remains concerned about this potential, and the investigation should indeed investigate potential pathways exploiting shallow sheeting fractures which may exist here, EPA's emerging CSM for this plume suggests that *steeply dipping fractures* are also important and may also likely exist as potential pathways in the bedrock. As noted

above, the plume, as drawn by Olin, has a longitudinal strike to the NNW. This strike orientation is common to fracture orientations observed in other areas of the site, which are mainly steeply-dipping. We further note that, although fractures of NE-SW strike were most of the orientations measured in the limited 24.5-foot interval of rock penetrated by GW-413, fractures of NW-strike orientation were indeed encountered near the base of the borehole, (e.g. fractures 20 and 21 mapped by Northeast Geophysical at 59.9 and 58.0 feet). Flow in the borehole appears to originate just above these depths, and the complex zone of intersecting water-bearing fractures from approximately 53 to 56.5 feet btoc, just above, may be influenced by NW-striking fractures, (although the complexity of the fracturing in this zone complicates interpretation). In any case, EPA remains concerned that the NNW-striking plume shape, which also corresponds to the general direction of the groundwater head gradient, is influenced by NW-striking fractures that cross-cut the regional NE-SW fabric. In view of this information, while accepting the elements of Olin's proposed investigation plan, EPA has added several seismic reflection lines and many additional GeoProbe locations. The additional work proposed is designed to maximize resolution of the subsurface in the region of the interpreted plume core, which is unknown, but may be trough-shaped and striking to the NNW parallel to fracture zones of this orientation. Additional seismic lines are intended to resolve the position and shape of the TOR and related features, and additional GeoProbe locations are needed to resolve groundwater concentration gradients in the high-concentration core areas as well as confirming the shape of the TOR surface in the general plume region. It is noted that the lateral spacing for GeoProbes, even with the additional locations, is on the order of 50-100 feet or more. EPA's proposed locations, which include all points Olin proposed and several additional points, have been arranged in transects which generally follow seismic lines and are transverse to Olin's interpreted plume centerline. It could be argued that an even tighter spacing is needed based on the known size and dimensions of the plume and its potential lateral extent. The following table and attached figures describe the locations and rationale for the additional work proposed (seismic lines and GeoProbe transects). While EPA is open to discussing the matter in view of potential opportunities for streamlining the program, we note that the current proposal (as-is) is weak in that it allows for very few locations for seismic data or follow-up confirmatory borings to interrogate the region where the *plume core* is likely/interpreted to be based on Olin's CSM. It is therefore imperative that the work plan is augmented to allow for validation and delineation of the plume within and beyond the known limits of the current configuration. Once the site team reaches a consensus on the final investigation program for this area, more accurate locations for permanent well installations for plume monitoring and remediation can be determined, but we recommend postponing those decisions until the new data is available.

Geophysical Survey Line	**Status**	**GW Profiling Transects/Comment**
1	Concur/Modify	GW profiling transect should be adjusted to follow seismic line 1. At least 2 new GeoProbe locations needed to resolve plume core; (see Figure).
2	Concur/Modify	GW profiling transect follows seismic line 2 alignment; at least 5 additional GeoProbe locations needed to NNW and SSE of GW-413 along seismic line 2 to resolve plume core (see Figure).
3	Concur	No confirmatory GeoProbe locations are planned, but this should be reevaluated following completion of seismic data

4	Concur	At least 3 additional GeoProbe points needed along transect which generally follows seismic line 4 transects; new points focused to delineate core location (see figure)
5	New	New 500-ft Seismic reflection line proposed south of Eames street; New GeoProbe transect of 8 locations with a lateral spacing of ~ 50 ft. (see figure).
6	New	New 300-ft Seismic reflection line proposed SW of GW-413 to define western edge of plume core; see Figure for proposed Geoprobe locations.
7A	New	New 1000-ft NW-SE oriented seismic reflection line proposed NW of RR tracks; GW profiling transect follows seismic alignment; at least 4 new GeoProbe points needed; see Figure.
7B	New	(Alternate to 7A); New 1000-ft NW-SE oriented seismic reflection line proposed NE of RR tracks in roadway between warehouses; GW profiling transect follows seismic alignment; at least 2 new GeoProbe points needed to augment existing transect in plume core region; see Figure.
8	New	New 200+-ft SW-NE oriented seismic reflection line proposed to define eastern plume core boundary; at least 1 new GeoProbe point needed to augment existing transect in plume core region; see Figure.
9	New	New 200+-ft SW-NE oriented seismic reflection line proposed to define eastern plume core boundary in region ~ 300 ft north of transect 8; at least 1 new GeoProbe point needed to augment existing transect in plume core region; see Figure.

14. <u>*Source for GW-413 NDMA contamination*</u>; As noted above, Olin's plan appears to be built on a working hypothesis that the soils in the former Plant B area are the source of the NDMA contamination detected at GW-413 in *shallow bedrock*. While EPA concurs that this is a reasonable working hypothesis, if the current program fails to identify a source in Plant B soils with the appropriate characteristics, it may be necessary to "go back to the drawing table" to entertain additional potential sources, which include, but are not limited to:

    - Subsurface soil and/or bedrock sources on Olin Property south and west of Plant B
    - Offsite sources along strike to the northeast and southwest of GW-413
    - Potential sources and/or migration pathways exploiting shallow sub-horizontal sheeting fractures in shallow bedrock beneath the former Plant B area or on Olin Property south and west of Plant B
    - Potential sources and/or migration pathways exploiting steeply dipping fractures in bedrock beneath the former Plant B area or on Olin Property south and west of Plant B
    - Complex transport pathways involving overburden, bedrock and possibly buried utility corridors beneath Eames street north of the site (where bedrock is likely to be shallow or near ground surface)
    - Etc.

    In any case, it may be necessary to drill into bedrock beneath the Plant B area, which is not included *per se* in the current phase of investigation. Drilling into shallow bedrock and perhaps

deeper bedrock may increase in importance depending on the results of the current phase of work. We propose to re-evaluate this situation once the seismic and direct-push data are available for review.

15. *East of Olin*; EPA concurs with the Olin's investigation plan for the areas East of Olin. We also concur with the proposal to defer identification of the number and location of confirmatory borings and monitoring wells until after the seismic data is in-hand for review. We have tentatively identified 21 provisional locations for confirmatory borings/vertical profiling of groundwater on the attached figure.

Specific Comments:

Section 2.2.1 - Bedrock Characterization Data Gap; Page 3, 1st Bullet; Revise as follows, "The bedrock topography, including both pinnacles, localized and larger scale depressions, saddles, and the overall basal configuration, .."

Section 2.2.1 - Bedrock Characterization Data Gap; Page 3, 2nd Bullet; It is not clear what "interconnectivity at the borehole scale" refers to? The concept of interconnectivity deserves additional discussion. A technical consensus is needed to guide future efforts. Identifying and resolving the interconnections *between* boreholes, i.e., from borehole to borehole, via direct and indirect means will require additional efforts beyond the "borehole scale". For example, pump testing, tracer studies, and various geophysical methods are some of the methods which may be used to identify interconnections between boreholes. The sum of these interconnections comprises the *network of interconnecting fractures*. Ultimately, the level of resolution on the fracture network will be dictated to some extent by the remedial technologies selected and the site-specific design, but clearly the assessments will require not only borehole specific testing, but assessments which evaluate fracture continuity and connectivity *between* boreholes.

Section 2.2.1 - Bedrock Characterization Data Gap; Page 3, 3rd Bullet; In addition to clarifying the "nature of contaminant transport within the bedrock formation," it will be necessary to identify *specific* critical migration *pathways* within bedrock for assessment, remediation, and monitoring.

Section 2.2.1.1 – Problem Statement; Page 5, 2nd paragraph; Minimum depth number of 10 feet into bedrock for Phase II confirmatory borings good. However, revise to quantify how deep beyond 10 feet Olin is required to core based on rock quality designation (RQD). For example, until competent – RQD greater than 90%.

Section 2.2.1.2 – Study Goals; Page 6, 2nd bullet; Please describe further how previous seismic refraction survey data will be, "incorporated judiciously in the verification process?" It may be necessary to selectively collect new seismic reflection data over previously collected seismic refraction lines as a means of establishing comparative metrics.

Section 2.2.1.2 – Study Goals; Page 6, 3rd bullet; It should be noted that drilling operations in the MMB swamp should not be ruled out. Drilling from a specialized drilling-barge platform is an option for future work. This method has been used successfully for decades and is readily available.

Section 2.2.1.2 – Study Goals; Page 6; The text states that the depth to competent bedrock will be determined "based on the rock quality description of a geologist". This process needs additional specificity. Please see general comments, above.

Section 2.2.1.2 – Study Goals; Page 6; What is the technical basis for the somewhat arbitrary choice of evaluating bedrock fractures "at a depth of up to ~100 ft below top of bedrock surface"?

Section 2.2.1.2 – Study Goals; Page 7; 1st bullet; Based on the field observation of soil borings in November 2019, the bedrock lithology can be distinguished from cobbles or glacial erratics.

Section 2.2.1.3 – Information Inputs, Page 8, bullets; The rules-of-thumb provided for the various "error bars" associated with the various data types are useful but site-specific results will need to be quantified and reported. Moreover, the basis for the numbers provided here merit additional explanation and/or documentation. For example, flow measurements are reported to have a resolution of "0.01 gpm". What is the range of flow measurements for which this "error bar" holds true? What type of flowmeter? In particular, the "error bar" of "Top-of-bedrock variability between geophysics and coring +/- 2 feet" is suspect and in need of careful analysis in preparing the final estimate. This is a composite term which will depend on the "error bars" for both drilling and geophysical estimation of TOR by different methods. It is not yet clear that any of these inputs are capable of a 2-ft error bar. The reality may be more on the range of 5-ft, but this will need to be clarified by future work.

Section 2.2.1.3.3 Borings and Borehole Logging Components; The text appropriately stipulates a drilling technology that is, "capable of collecting core samples that will identify the weathered/competent bedrock interface". As discussed in the general comments above, this merits additional discussions. For example, how will the "top of weathered bedrock" be defined? How will the top of "competent bedrock" be defined? How will water-bearing bedrock fractures be defined? How will they be identified? How accurate will these determinations be given HPFM measurements are usually not collected on a tight vertical discretization? It will be necessary to not only more accurately define these parameters of interest, but also to describe how they will be measured, and at what level of accuracy and precision. Additionally, this section states that the Phase II borings will be drilled using a sonic drill rig *or equivalent.* Consider air rotary for the rock cores or a sonic rig with a diamond drill bit; cores damaged by the rig upon retrieval need to be minimized.

Section 2.2.1.3.3, Borings and Borehole Logging Components, page 10; Please see general comments above. The project team needs to reach consensus for unambiguous technically-based definitions for "weathered rock" and "competent rock" in order to maximize accuracy and precision of depth determinations for these key features of interest.

Section 2.2.1.3.3, Borings and Borehole Logging Components, page 10; In addition to "observation of fractures," recovered core should be logged to include all pertinent observations relative to rock type, grain size, presence of compositional layering, foliation, etc., attitude, aperture, and character of fractures, weathering, and other relevant characteristics.

Section 2.2.1.3.3, Borings and Borehole Logging Components, page 10; Based on previous borehole geophysical logging efforts at the site, all fractures are not typically evaluated for water-bearing characteristics. For example, HPFM logging has been typically conducted on a relatively large vertical spacing, and as such, it may not be possible to positively identify all relevant water bearing fractures.

Similarly, flowmeters tend to vary in terms of the discernable range of flow ("sweet spot") inherent to the device. For example, the flow meter device used in typical HPFM platforms is commonly unable to distinguish very low flows or very high flows. These scenarios may occasionally lead to incorrect false reporting of NMF (no measurable flow). In this light, please clarify how "competent vs. fractured bedrock flow characteristics (flow rate and head measurements from borehole testing)" will be implemented to make such distinctions?

Section 2.2.1.4.1; The goals of the seismic surveys planned for the CA could benefit from additional specificity. For example, in addition to a more highly resolved understanding/depiction of the top-of-(weathered) bedrock surface, a related objective is to produce a companion depiction of the top-of-(competent) bedrock surface. The shapes of these two surfaces will determine lateral and vertical variation in the uppermost weathered/highly fractured bedrock layer which may be an important and distinct feature relative to DAPL remediation efforts. This information may be presented as a thickness map for weathered/highly fractured bedrock. As discussed in the general comments above, consensus definitions for these horizons are needed. The text appropriately acknowledges the additional goal of determining the depth of the as-built slurry wall in relation to the weathered and competent bedrock surfaces. A thickness map of the upper weathered and highly fractured bedrock can be a valuable tool for these assessments.

Section 2.2.1.4.1 – Containment Area; Page 12; First Paragraph; *Four* confirmatory boring locations could yield lower resolution than desired.

Section 2.2.1.4.5 – North of Olin – GW-413 – Area; Page 17; First paragraph; Regarding the *eleven direct push locations to refusal*, why not use the same 10-foot standard proposed for all of the other borings?

Section 2.2.1.4.5 – North of Olin – GW-413 – Area; Page 17; Second paragraph; Regarding the *shallowly-dipping sheeting fractures,* with optical televiewer used to confirm.

Section 2.2.1.5, Subsequent Investigations; EPA concurs with Olin's suggestion to make final decisions on number, placement, and location of monitoring wells and borings until Phase 1 work and data is used to reach consensus among site team members.

Section 2.2.1.7, Performance or Acceptance Criteria, page 19, 4th ¶; Additional information is needed to clarify how the "verification flight" will be used to confirm that, "the AEM is fit for its intended purpose and that the ensuing data collection will meet quality assurance/quality control (QA/QC0 requirements". What are the QA/QC requirements? Please supply appropriate references and/or SOPs and refer to these in the text.

Section 2.2.2, NDNA Plume Characterization Data Gap; EPA concurs that the "source, fate and transport characteristics for NDMA contaminated groundwater in the norther area of the Olin Property require additional conceptualization." EPA concurs with this statement. Please see general comments above.

Section 2.2.2.1.1, NDMA Data Gap Problem Statement, North of Olin (GW-413) area; EPA concurs that there is a "lack of understanding of the source, migration pathway and fate of NDMA from the source to GW-413D and beyond." While EPA concurs with the stated goal (1st bullet) of, "Evaluating the former Plant B Production Area building as a potential NDMA source," it is not yet clear that this is indeed the source. It therefore remains possible that if a clear source is not located near Plant B, then additional source area identification and delineation steps will be needed before the secondary goal (3rd bullet),

can be completed, i.e., "Understand the source, migration pathway and fate of NDMA from the source to, and downgradient from GW-413D." EPA has proposed additional investigations beyond those originally proposed by Olin so that a more robust source area investigation can be completed relative to Plant B. Additional efforts may still be needed in a subsequent phase. Please see also general comments, above.

Section 2.2.2.2. NDMA Data Gap Study Goals; Additional clarity is needed with respect to the stated goals here. For example, the text states (1st ¶) that the study goals are as follows:

1) determine *if a source can be identified* for the NDMA plume to the north of Olin,

2) verify the extent of NDMA contamination to the north of Olin,

3) develop a conceptual model on the source and transport of NDMA to the north of Olin, and

4) determine locations for additional monitoring well clusters.

Later in this section the decision statements for NDMA characterization are stated as follows:

- Determine *whether the former Plant B production area is a potential source* of elevated NDMA concentrations to the north of Olin.
- Define the extent of NDMA in the vicinity and north of GW-413.

It must be noted here that a negative conclusion to the Plant B determination would not be definitive with respect to determining if a source *can be identified* for the NDMA plume north of Olin. Under such a scenario, EPA will require additional source area identification and delineation efforts in a separate/new phase of investigation. The source must be located before the other listed goals, i.e., extent, fate and transport, CSM, monitoring, etc. can be addressed. EPA has proposed additional investigations beyond those originally proposed by Olin so that there is a greater probability that the results will reach a definitive conclusion regarding a Plant B source. If the role of Plant B is diminished by the investigation, additional efforts may still be needed in a subsequent phase to locate the source. Please general comments, above, where EPA has offered preliminary suggestions on other potential sources and pathways exclusive to Plant B.

Section 2.2.2.4. NDMA Data Gap Boundaries of the Study; The text states that the soils will be sampled at "designated depth intervals." What are they? How do these sampling intervals relate to potential and suspected modes of NDMA release to the environment? Please clarify.

Section 2.2.2.4. NDMA Data Gap Boundaries of the Study; The text states that, "In addition, there will be a synoptic round of groundwater level measurements for 14 wells." Please specify which wells are to be included for EPA review and comment.

Section 2.2.3. DAPL Pool Characterization Data Gap; The work plan appropriately notes that, "The Phase II DGWP will also specify casing completion methods in bedrock below the DAPL pools." In the general comments above, EPA has offered some suggestions for drilling methods and sequencing, but we look forward to working with the Olin team to reach a consensus on the methods and approaches which will result in the best data set while safeguarding against cross contamination, casing leakage, and other problematic issues.

Section 2.2.3. DAPL Pool Characterization Data Gap; Page 24; 3rd Paragraph; Analysis should include *specific conductivity and NDMA analysis,* in addition to *specific gravity measurements.*

Section 2.2.4. Site-Wide Issues; The issue of fracture interconnectivity is a critical one which deserves additional discussion in terms of inputs, analytical methods, presentation options, etc. While EPA does not object to the short description of the approach outlined here, we believe the issue would benefit from additional technical discussions. It is not clear that the work outlined in this work plan alone will be enough to delineate pathways of interconnected fractures. Additional work/phases may be needed.

Section 2.2.4.1. Surface/Groundwater Interaction; The additional actions listed here will improve the understanding of GW/SW interactions, but resolution of pertinent issues, such as locations of groundwater discharge to surface water and sediment will likely require additional work at a finer level of resolution, and possibly additional methods. For example, thermal methods are commonly used with great success to identify groundwater discharge areas at a variety of scales. We propose to evaluate the composite GW/SW data set resulting from the implementation of this work plan, iterating as necessary to improve resolution in key areas of the vast site.

Section 3.2.3. Monitoring Well Replacement; It may be worth discussing the drilling methodology, sequencing, and casing methods. Please see general comments, above, and comment above regarding casing completion (Section 2.2.3. DAPL Pool Characterization Data Gap).

Section 3.2.7. Surface Water Gauging Station Installations; EPA believes that a higher density of surface water head measurement stations will ultimately be needed in order to produce enough resolution of the hydrology, GW/SW interactions, and particularly localized areas of groundwater discharge to surface water and sediment. We propose to evaluate the composite GW/SW data set resulting from the implementation of this work plan and iterating as necessary to improve resolution in key areas of the vast site.

Section 3.3. Phase II Work Plan. The text provides initial estimates for the number of permanent monitoring wells to be installed in Phase II. While these estimates are reasonable first approximations, review of Phase I data will be needed in order to reach consensus on the full scope of locations and depths needed. Based on our assessments and comments, above, EPA believes that this review will undoubtedly result in additional wells beyond what are proposed here. For example, it is likely that the North of Olin plume will require more that 4 clusters, including bedrock installations in the Plant B area, where none are proposed now.

Section 3.3 – Phase II Work Plan – Page 32; First paragraph; Groundwater samples to be analyzed for *specific conductivity and NDMA,* in addition to *specific gravity measurements.*

Section 3.3 – Phase II Work Plan – Page 32; Second paragraph; Regarding the range of Phase II borings summarized in this section, we are moving towards multi-port wells in known or suspected areas of DAPL as the standard for the Site going forward. The justification would be the physical characteristics of the contaminant matrix; standard monitoring wells will likely not yield as useful information as the multi-port wells.

Section 4.1.7.2 – Well construction and development – Page 37 – What is the plan for mitigating the amount of encountered DAPL from sinking into the open boreholes?

Section 4.1.9 – CSM update and USEPA meeting – Page 37 – Regarding the *3D bedrock model,* EPA needs to be able to inspect this model electronically and view the database used to generate the model.

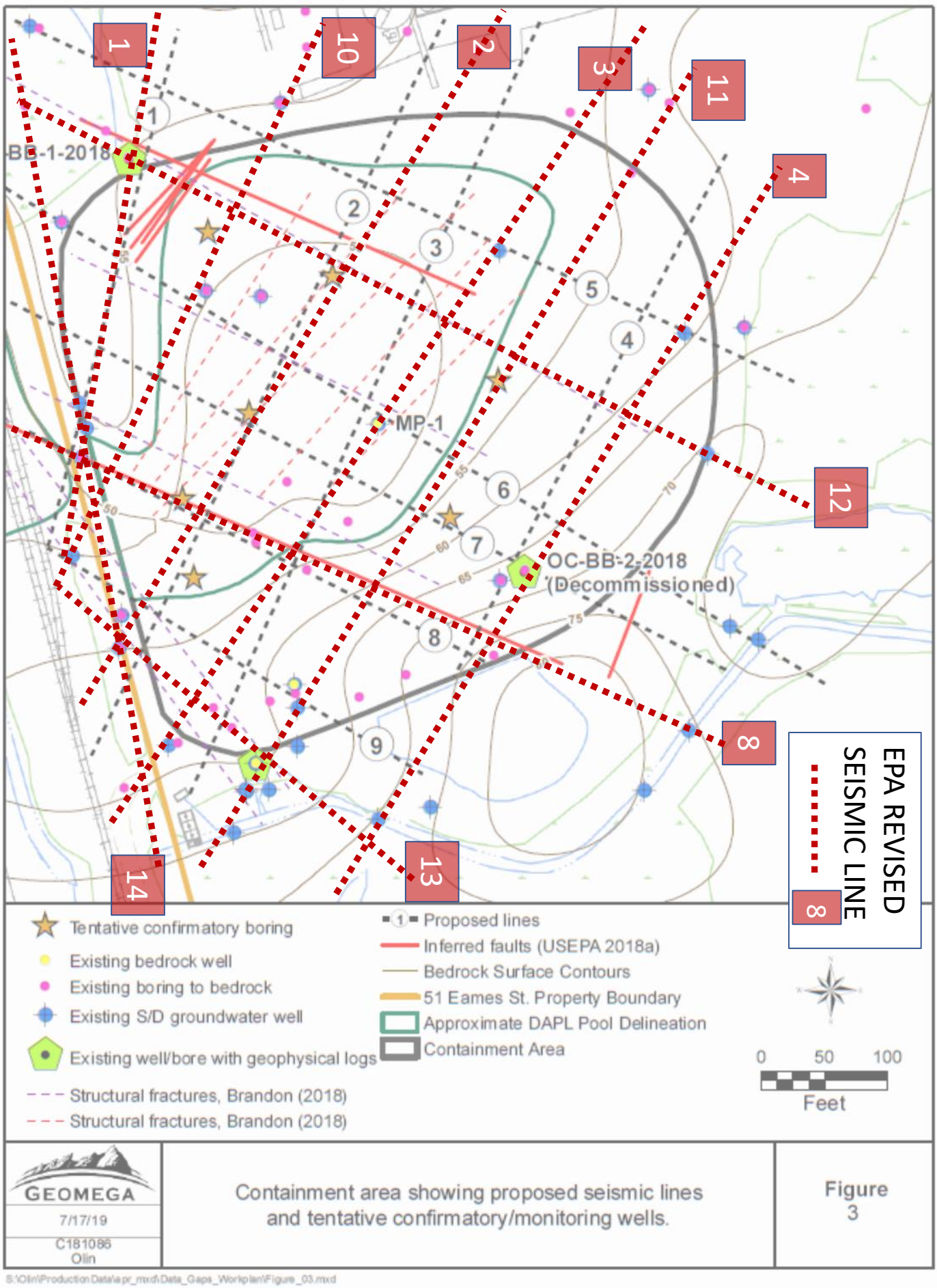
Appendix E – Field Sampling Plan, Section 2.2.4; Synoptic groundwater level measurements; Given the scale and huge area covered by the site, the lateral and vertical resolution of the groundwater head field is not optimal. A comprehensive evaluation of the existing monitoring well network should be undertaken to determine locations and depths at which additional head control points are needed to adequately constrain and resolve the groundwater flow field.

Figures to Accompany

Conditional Approval of Surface Geophysical Data Collection portion of Data Gaps Work Plan

W. Brandon

12-17-2019



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Olin

Containment area showing proposed seismic lines and tentative confirmatory/monitoring wells.

Figure 3

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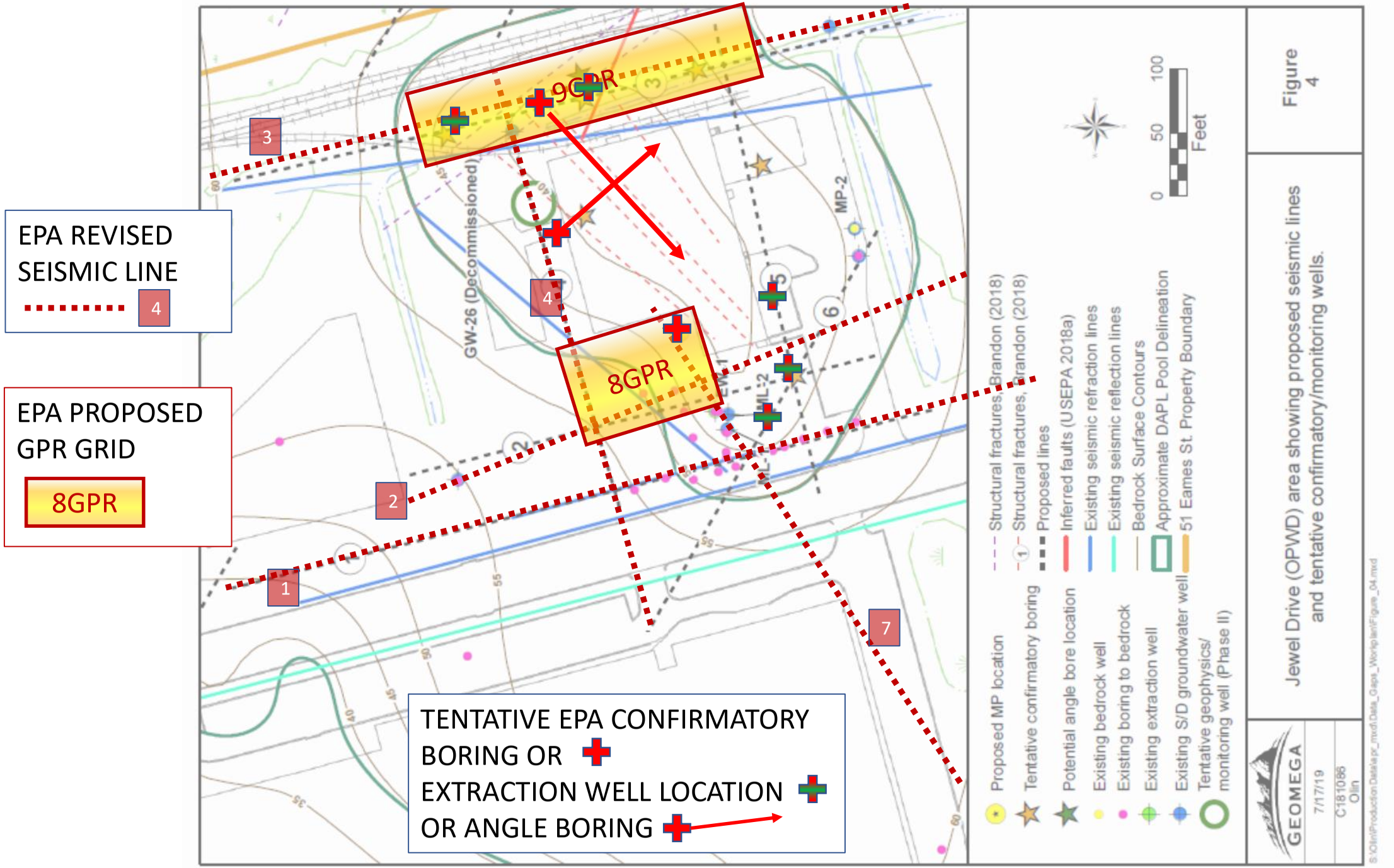
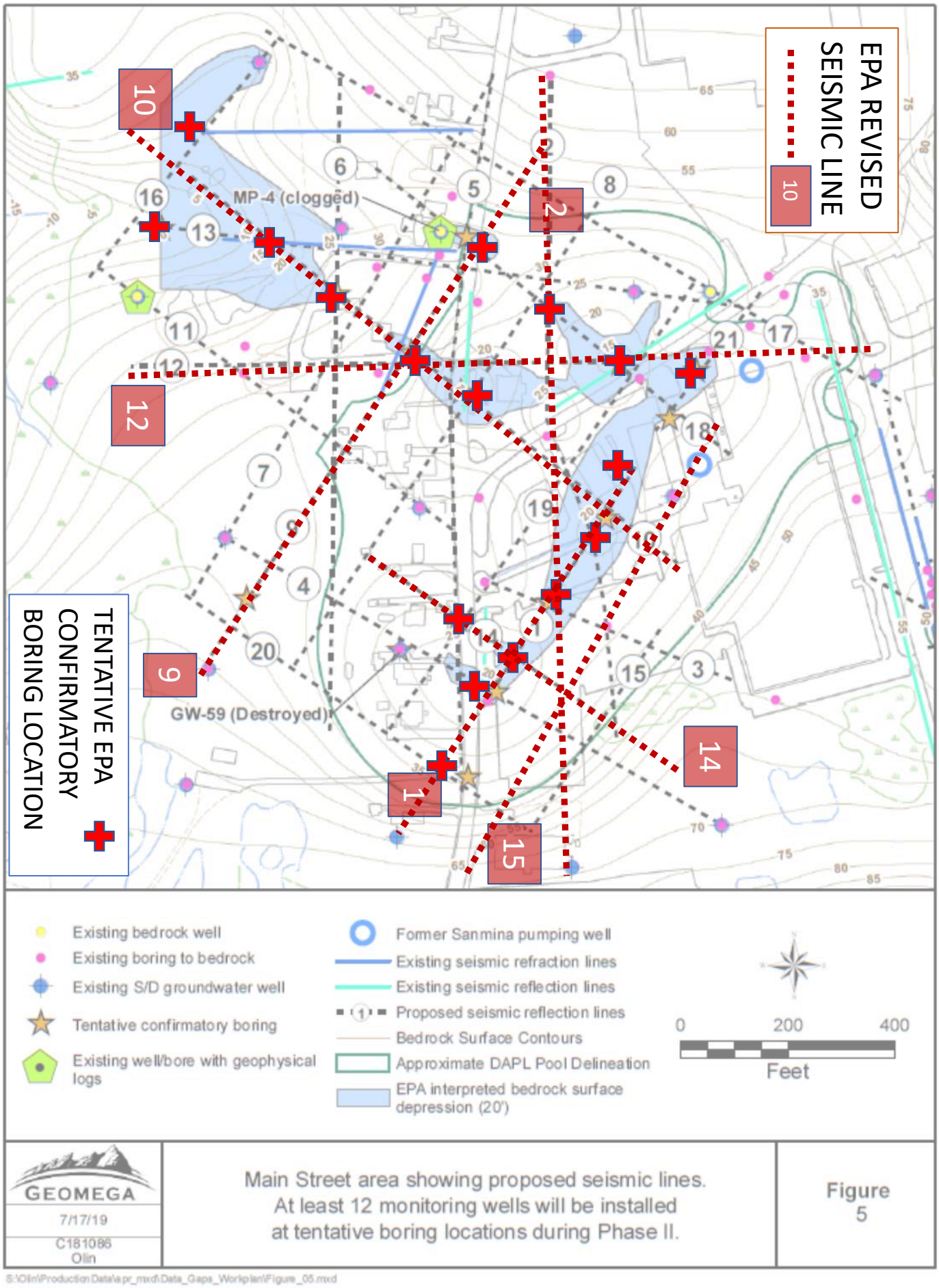

EPA REVISED SEISMIC LINE
4
EPA PROPOSED GPR GRID
8GPR
9GPR
8GPR
3
4
2
1
7
5
6
MP-2
GW-26 (Decommissioned)
TENTATIVE EPA CONFIRMATORY BORING OR EXTRACTION WELL LOCATION OR ANGLE BORING
Proposed MP location
Tentative confirmatory boring
Potential angle bore location
Existing bedrock well
Existing boring to bedrock
Existing extraction well
Existing S/D groundwater well
Tentative geophysics/ monitoring well (Phase II)
Structural fractures, Brandon (2018)
Structural fractures, Brandon (2018)
Proposed lines
Inferred faults (USEPA 2018a)
Existing seismic refraction lines
Existing seismic reflection lines
Bedrock Surface Contours
Approximate DAPL Pool Delineation
51 Eames St. Property Boundary
0
50
100
Feet
Figure 4
Jewel Drive (OPWD) area showing proposed seismic lines and tentative confirmatory/monitoring wells.
GEOMEGA
7/17/19
C181086
Olin



GEOMEGA 7/17/19 C181086 Olin	Main Street area showing proposed seismic lines. At least 12 monitoring wells will be installed at tentative boring locations during Phase II.	Figure 5

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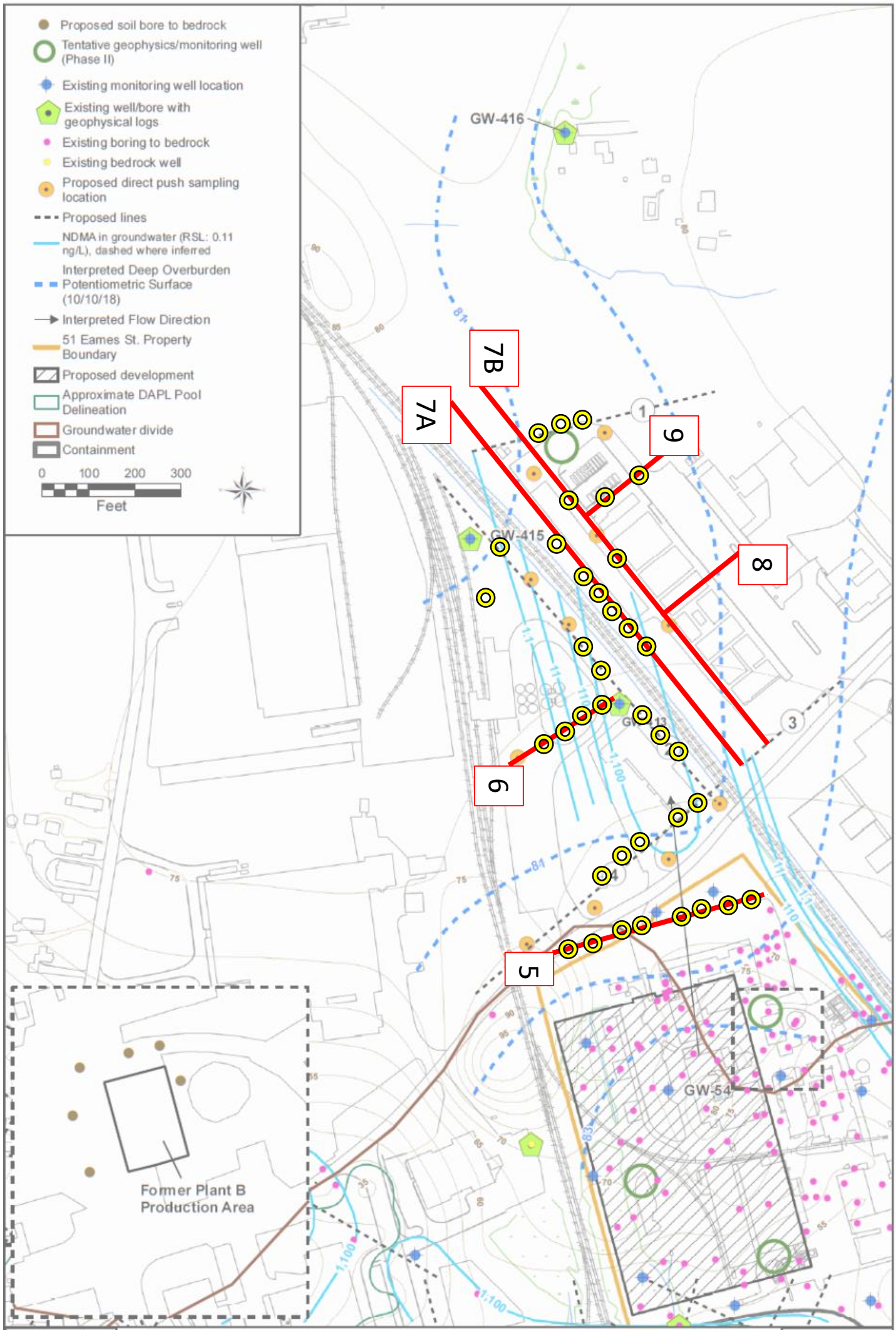

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North of Olin (GW-413 area) showing proposed seismic lines, direct push sampling, and tentative geophysics/monitoring wells in relation to the NDMA plume (After Wood 2019c). Inset shows proposed soil bore locations around the former Plant B production area.

Figure 7

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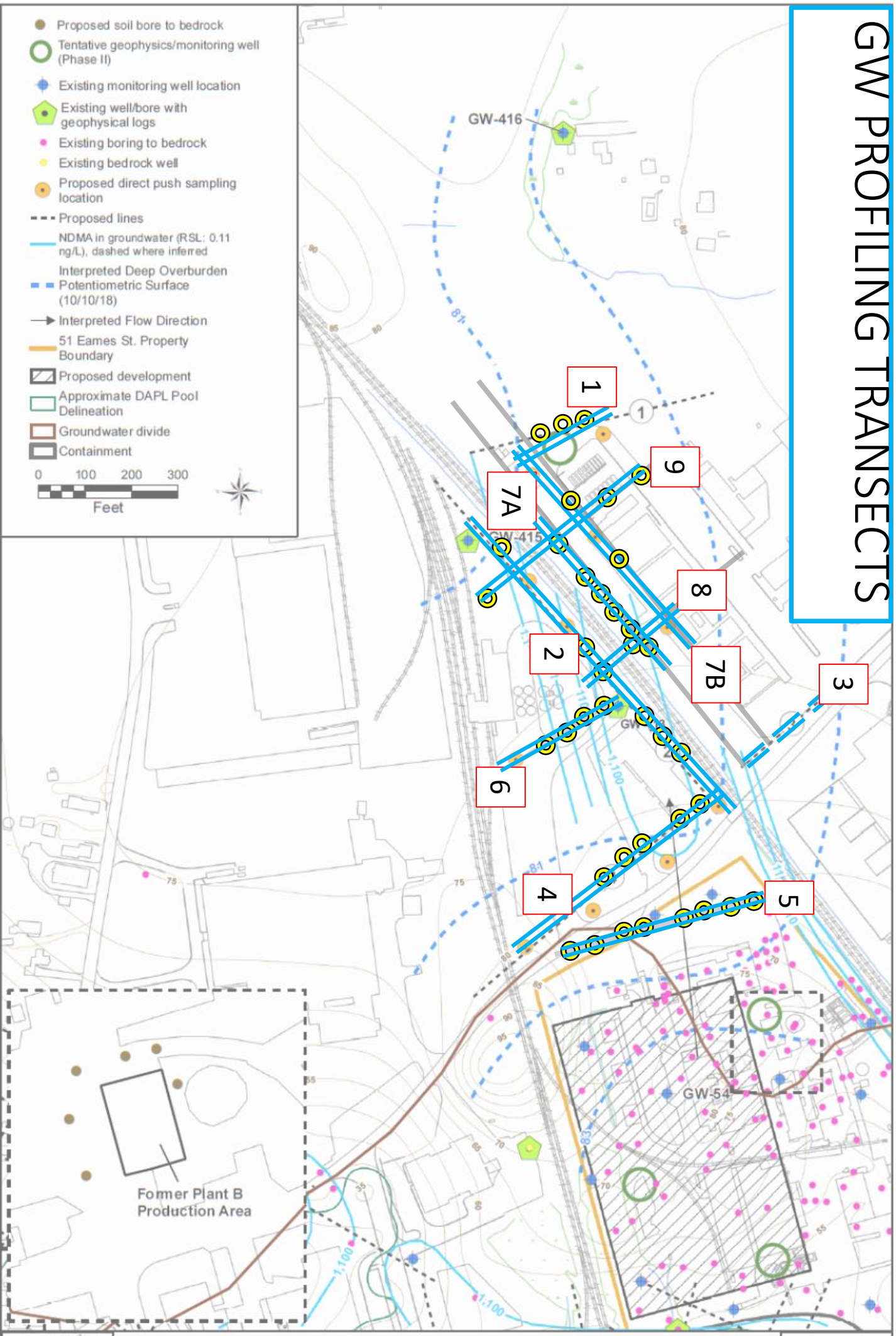
GW PROFILING TRANSECTS



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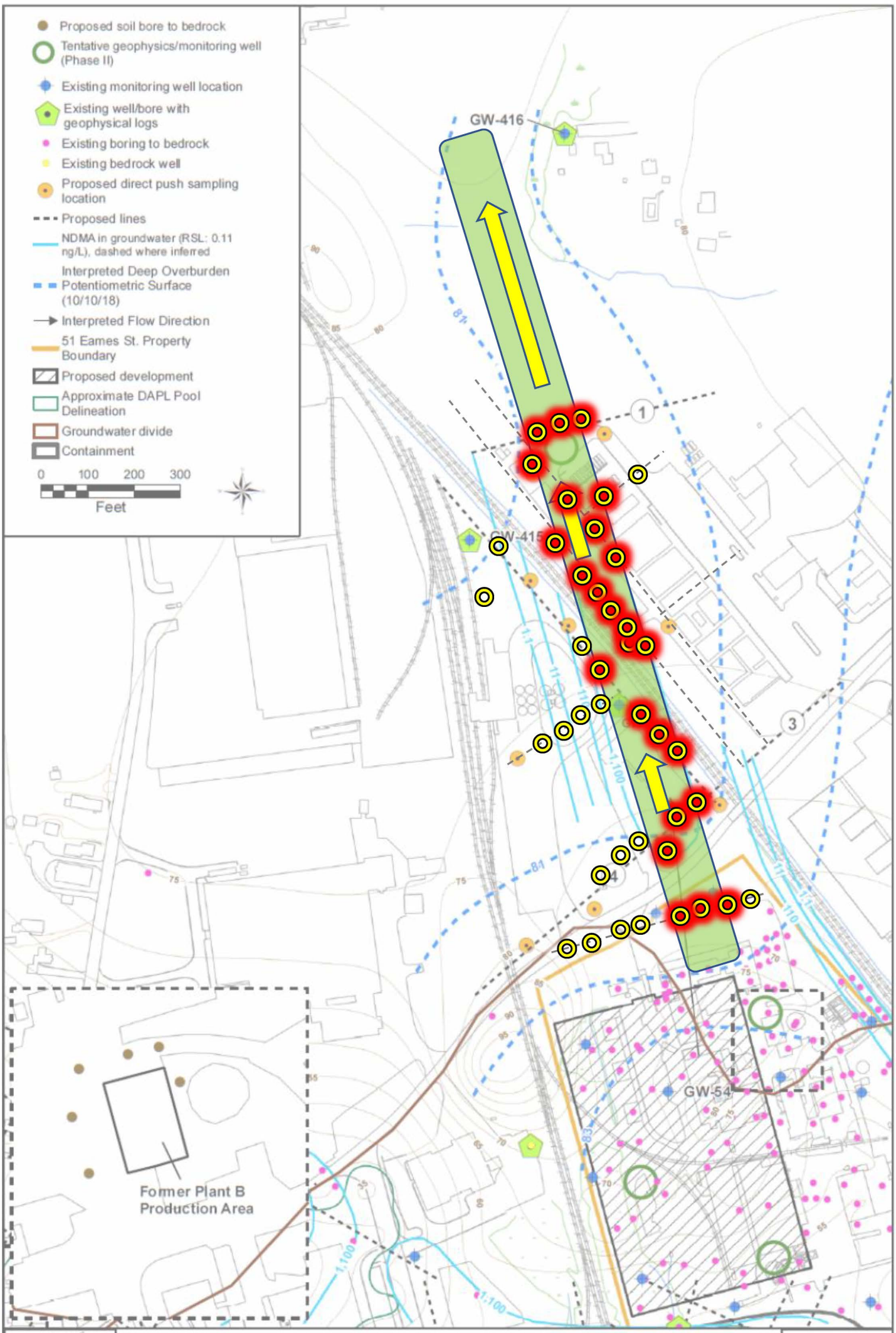
North of Olin (GW-413 area) showing proposed seismic lines, direct push sampling, and tentative geophysics/monitoring wells in relation to the NDMA plume (After Wood 2019c). Inset shows proposed soil bore locations around the former Plant B production area.

Figure 7



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Olin

North of Olin (GW-413 area) showing proposed seismic lines, direct push sampling, and tentative geophysics/monitoring wells in relation to the NDMA plume (After Wood 2019c). Inset shows proposed soil bore locations around the former Plant B production area.

Figure 7

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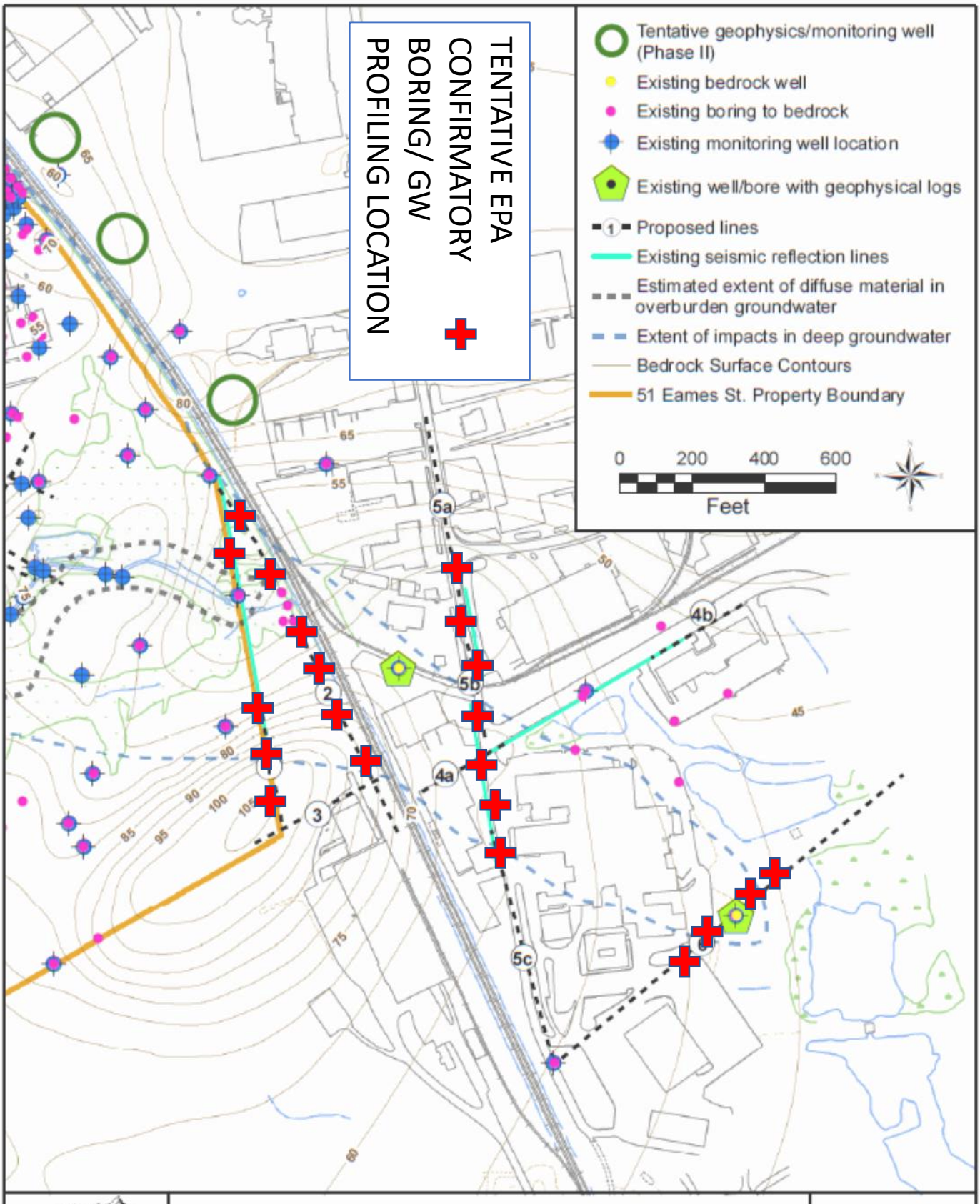

GEOMEGA

7/16/19

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East-of-Olin area showing proposed seismic reflection lines and tentative geophysics/monitoring wells.

Figure 8

S:\Olin\ProductionData\apr_mxd\Data_Gaps_Workplan\Figure_08.mxd

MEMORANDUM

To:	EPA
Copy To:	File 80021
From:	J. Lambert, J. Brunelle
Subject:	Olin: Comprehensive Data Gaps Work Plan Review Comments
Date:	8/22/19

Nobis Group® (Nobis) on behalf of the U.S. Environmental Protection Agency (EPA), has reviewed and generated the following comments on the "*Data Gaps Work Plan*" prepared by Geomega, Inc. (Geomega) on behalf of the Olin Corporation (Olin) for the Olin Chemical Superfund Site (Site) in Wilmington, Massachusetts (Geomega, 2019).

1.0 MAJOR COMMENTS:

1. Olin's document includes the final RI/FS work plan Volume II (Project Operations Plan, Site Management Plan and Community Relations Support Plan) and Volume IV (Health and Safety Plan [HASP]) as Appendix H. Several details related to site management, community relations, and safety have changed since this document was produced 10 years ago. We recommend providing replacement text or redline/strikeout for the following sections:
   a) Section 2.1 (Project Team Members).
   b) Section 2.2 (Roles and Responsibilities).
   c) Table 2-1 (Project Team Contact Information).
   d) Table 3.1-1 (List of Properties Where Property Access May Be Required).
   e) Figure 2.0-1 (Project Organization and Communication).
   f) Figure 3.1-1 (Properties Where Access May Be Required).
   g) HASP organization chart.
   h) HASP: discussion of hazards specific to the helicopter-based AEM survey.
   i) HASP: updates to Safety Data Sheets (SDS) for products used.
   j) HASP: Maple Meadow Brook Wetland sampling, if changes have been made.

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2. The surface geophysics data should be validated using at least one additional method.
   a) Section 2.2.1.3.1: The seismic reflection surveys near the DAPL pools should include at least two lines per target area using EM methods to compare depth of bedrock and determine the vertical extent of high-conductivity material within bedrock.
   b) Section 2.2.1.3.2: The AEM survey should be calibrated by comparing to ground-based EM transects in addition to the existing seismic transect and borehole data. A more accessible area within the general AEM survey area (such as the Town Park parcel) may be used for this calibration.
3. Section 2.2.2 identifies two NDMA data gaps north and east of the Olin property. We consider the bedrock to have additional data gaps, as NDMA has been detected regularly in some residential wells. Olin should install additional deep bedrock boreholes or perform additional evaluations (such as discrete-interval sampling and geophysics) in the following areas with frequent NDMA detections and/or multiple wells:
   a) Map 3 Lot 2 area
   b) Cook Ave and area upgradient (to the northwest)
   c) Olin may also consider locations M-02/L-07, M-01/L06 and M-15/L-02/M-27-L-14.
4. We agree on the general plan for Phase II and Phase III and that the details regarding these investigations will be based on results from Phase I. However, we may determine that additional investigations that have not been anticipated in this work plan will be needed. Well replacement should be included in Phase II for wells or sampling ports that have been compromised during recent work.

2.0 MINOR COMMENTS:

2.1 Section 2: Data Gaps Identification

1. Section 2.2.1.3.3: Borehole geophysical logging methods should also include the following:
   a. Gamma logging: This may detect the presence of sealed fractures and support evaluation of lithologic changes in the borehole.
   b. Borehole deviation: This is generally available as part of the ATV and other borehole logging probe and may indicate preferential fracture zones or structural rock variability. Borehole deviation analysis may identify issues with installing wells and other monitoring infrastructure.
2. Section 2.2.1.4.2 envisions installing a single deep bedrock borehole east of the building in Phase I and installing additional confirmatory shallow bedrock boreholes in Phase II. Olin should be prepared to install at least one deep bedrock borehole west of the DAPL

pool in a later phase of work to evaluate potential bedrock geology and groundwater concentrations between the Off Property West Ditch (OPWD - Jewel Drive) and Main Street DAPL pools.

3. Section 2.2.4.1 describes surface water/groundwater interaction data gaps. EPA has recently provided a memo requesting additional characterization of surface water. The revised Work Plan should incorporate the results of that evaluation and CSM discussions with the stakeholder team.

2.2 Section 3: Work Plan

4. Section 3.2.3: Please specify the drilling methods to be used to replace overburden monitoring wells.
5. Section 3.2.6: Please add SEA-3 and SEA-3BR to the list of existing wells to be sampled to confirm previous results.

2.3 References

6. Please add the following references from the report, or correct the report text if they are in error:
    a. GEI, 1998.
    b. MACTEC, 2004.
    c. MACTEC, 2006d.
    d. DAPL Extraction pilot test (November 7, 2014).
    e. Supplemental DAPL extraction memorandum (February 5, 2015).
    f. Most recent SASR.

2.4 Appendix E – Field Sampling Plan

7. Section 2.1: please include the target analyte list for the packer testing for the deep bedrock well proposed at Jewel Drive in this section. Olin should provide a full analyte list and a list of sample priorities should a given packer interval not provide enough water for a full sample.
8. Section 2.2: Packer testing should be included as a subsection.
9. Section 2.2.1 describes direct push soil sampling. Please confirm that the soils will be logged continuously and provide a description of the decision tree/rationale for selecting individual soil samples within the depths described.
10. Section 2.2.4 describes a limited synoptic groundwater level measurement round concurrent with the groundwater sampling.

a) Olin should conduct a full synoptic gauging event, or at a minimum add the GW-400 cluster (well control north of the target area), the GW-406 cluster (bedrock well control southeast of the target area), and GW-48S (or another well or cluster on the northeast side of the Olin property if GW-48S is not available) to provide a more complete view of the water levels north of the Olin property.

b) The timing of this water level round relative to the installation of surface water gages is unclear; however, water levels at all available surface water gauges should also be measured as part of this event. These should include at a minimum the existing gauge at the Middlesex Canal.

11. Section 3 should include a description of the borehole geophysics work to be performed at the deep bedrock borehole proposed at Jewel Drive, or the report should include descriptions of the instruments and applicable SOPs to be used. Section 3.3 of Appendix D describes instrument calibration performed in 2009 and may not refer to the correct geophysical subcontractor or equipment selected for this evaluation.
12. Section 3.2 describes the direct push groundwater sampling. Please explain the procedure if a groundwater sample cannot be collected at a particular depth, such as the number of new attempts at different depths.

3.0 REFERENCES

Geomega, 2019. Data Gaps Work Plan. Prepared for Olin Corporation. August 2.